POLICY BRIEF

June 2021
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

Water and wastewater management in the fruit and vegetable processing industry

A recently completed Water Research Commission (WRC) study investigated the water and energy use efficiency and wastewater generation within the fruit and vegetable processing industry. This was the second survey of its kind following studies undertaken by the WRC and the Department of Water and Sanitation in the 1980s. The latest study benchmarked the intensity parameters (specific water intake, specific effluent generated, specific electricity consumption and specific fuel consumption) with international best practice as well as the status in 1987 when the previous study was undertaken. The study aimed to provide an understanding of the current best practices within the fruit and vegetable processing industry, including how the industry has progressed and changed since 1987.

Background

In the 1980s, the WRC with the Department of Water and Sanitation embarked on a series of national surveys of the water and wastewater management of several industries in South Africa. These so-called NATSURV reports, as they are known, have been well used over the past three decades. However, the South African economy and its industrial sectors have either grown or, in some cases, shrunk considerably since the 1980s, so that the economic landscape has changed.

New technologies and systems have been adopted by some of the industries; certain information contained in the national surveys therefore can be considered outdated or obsolete. Furthermore, initiatives like the United Nations CEO mandate, water stewardship initiatives, water allocation and equity dialogues, and others suggest a growing awareness of water use, water security, and wastewater production.

In this context, it is now considered an opportune moment to review the water and wastewater management practices of the different industrial sectors served in the NATSURV reports and to make firm recommendations on directions for change. This project is a revision and update of ***NATSURV 14: Water and wastewater management in the fruit and vegetable processing industry***, which was published in 1987.

Rationale for the study and project approach

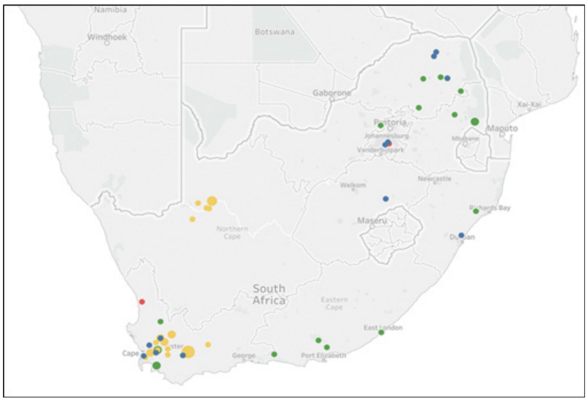
Fruit and vegetable processing industries produce effluent streams that contain high pollutant loadings with a negative impact on the environment if not treated effectively and satisfactorily before discharged into public water sources or municipal sewerage systems. Ineffective treatment or process operations may also lead to serious odour problems.

High organic loadings in the effluent streams from the fruit processing activities present considerable problems for municipalities and the environment. Any improvement in water management and minimisation of pollutant loads in these effluent streams will be invaluable in helping contribute to improved water demand management and pollution control in our water-scarce country.

A comprehensive literature search and review was undertaken to establish the current size, nature and status of the fruit and vegetable processing industry (FVPI), both locally and internationally. The emphasis was on water and especially wastewater management in the industry. The local industry was mapped and quantified as comprehensively as possible. Included were water usage rates for different types of FVPIs, their specific water intakes and the volumes of effluent generated.

Based on the mapping of all FVPIs on a national basis (Figure

1), a representative sample of all the different types and sizes of industries was selected for further study. These selected FVPIs were visited, surveys undertaken and assessments made of the various process steps, including the volume of water used in the preparation processes, effluent volumes generated and discharged, recycling practices, and specific water intake practices. Details on specific pollutant loads were also obtained. The survey also gathered information on wastewater treatment processes used in the fruit and vegetable processing industries for the removal of mainly organic material and locations at which effluent was discharged.



Figures 1: Locations of verified processing facilities in South Africa

The processes used for the treatment of the discharged effluent were critically evaluated from a water economy, effluent generation and energy consumption perspective, as well as the treatment efficiency of the removal of the most important pollutants from the effluent. Best practices were identified and recommendations provided for best and preferred technologies to be used in the FVPI and for optimising or improving existing treatment processes.

Main project outcomes

A key feature of the FVPI at present is its strong export-oriented approach to production and its focus on intra-Africa trade, in particular. The pivotal commodities in the industry are fruit juice concentrates and canned vegetable products, with a total production value of slightly over R10 billion and R6 billion in 2014, respectively. Another important aspect of the industry is its highly competitive and concentrated nature, with a few key players controlling large portions of both production and employment.

The location of processing facilities is generally determined by their proximity to raw inputs, with only a few exceptions. The Western Cape was found to be the leading location of processing facilities, where the juicing and canning of deciduous fruits dominated. The Eastern Cape, Northern Cape, Limpopo and Mpumalanga provinces are other key provinces where fruit and vegetable processing take place.

Water use in the sector

The average specific water intake (SWI) for the canning process were found to be 6.81 m^3/ton raw material and 8.22 m^3/ton of product, and for juicing it was 3.79 m^3/ton raw material and 4.45 m^3/ton of product, for freezing the values were 16.3 m^3/ton raw material and 4.8 m^3/ton of product, and for drying it was 1.3 m^3/ton raw material and 15.0 m^3/ton of product.

The average SWI for all these processing types were 6.71 m^3/ton raw material and 7.96 m^3/ton of product. The corresponding SWI values that were reported in the first version of the NATSURV for the FVPI (1987) were 8.79 m^3/ton for canning, 1.29 m^3/ton for juicing, 14.5 m^3/ton for freezing, and an average of 9.29 m^3/ton for all the process types (all expressed in terms of tons of raw material). Drying processes were not reported on in the 1987 study.

It is encouraging that some of the facilities reported SWI figures comparable to or better than that of their international counterparts. In addition, some facilities performed well in relation to the SWIs established for certain products in the original 1987 study. Many of the facilities have dedicated long-term strategies for improving water use, with one facility, in particular, having almost halved water consumption over a three-year period.

In general, it was found that the raw material and facility cleaning were the main consumers of water, and therefore initial water saving endeavours should be directed at these operations. It must, however, be noted that improvements in water efficiency in the South African FVPI are not only motivated by desire for environmental protection or drought risk, but also for financial reasons. The costs of water consumption and effluent disposal can be reduced by improving the water efficiency of the processes.

Water scarcity resilience

Water quality was reported as vital both in the processing process and as an ingredient in some products (e.g. beverages). The pre-filtration of municipal water with carbon filtration systems was required for some industries to ensure that they comply with food and health safety standards to remain internationally competitive (protecting their reputation) and to ensure resilience to lower water quality impacts.

Water tariffs were increased for industries during the restrictions, but not with the same harsh tariffs as for household water use, although the total water use requirements were high in some cases. Production costs generally increased. The cost could not be passed on to the consumer, which resulted in reduced profit margins and therefore reduced financial resilience to water restrictions.

Identified barriers to water resilience

Water resilience is only one element of agricultural value chain resilience. The following barriers to increasing water resilience were identified:

- Lack of proper maintenance and refurbishment of infrastructure. Income derived from water sales/tariffs is not ringfenced for this purpose. Lack of technical expertise and knowledge in some local authorities result in the poor maintenance and management of their water infrastructure. This can result in excessive water losses and water use which is unaccounted for.
- The quality of the water provided to users can sometimes be below acceptable standards during low levels at storage facilities or due to leaks in distribution systems. This can seriously impact on the agri-processing sector, which relies on water of a very good quality to meet hygienic requirements.
- The impact of high water tariffs during water restriction periods on the financial viability of the agri-processing sector is significant. It was requested by interviewees that this be brought to the attention of local authorities. These companies buy large volumes of water from their water service providers (municipalities), contribute towards the income of the local authority through their rates and taxes and provide job opportunities to many people in that town. The financial viability of the agri-processing companies is severely negatively affected by the high water tariffs, which can be detrimental for local authorities if more industries acquire their own water sources and go off-grid.

Proposed interventions

A number of interventions were proposed by stakeholders in the fruit and vegetable processing industry, including:

- Public perceptions on the reuse of wastewater within the food industry should be changed through education and capacity-building programs to create an understanding of the safety of reuse systems.

- Water augmentation options should also include desalination of seawater, the development of groundwater resources and the reuse of treated effluent to create increased resilience through diversification. Current water supply options are all reliant on surface water (rainfall), which results in an unacceptably high water undersupply risk for the agri-processing sector.

- Improved maintenance of bulk water infrastructure by local authorities is required to reduce losses in water supply systems. This will also ensure that all possible winter surface water runoff is captured in storage dams and then made available to water users.

- Water savings incentives/financial support from local authorities/government are required to support agri-businesses in embarking on water saving initiatives. The very low profit margins of the industry limit their ability to embark on these initiatives without support. The reduced water demand resulting from these initiatives can be regarded as water augmentation options for local authorities.

- Agri-processing companies can sponsor water-efficient appliances/technologies for their staff to implement at their houses. Some companies support their staff by providing information, but not appliances/technologies.

- The metering of water throughout the agri-processing phases should be standard practice, as it can indicate critical areas where water savings can be achieved. This can include real-time monitoring. Water metering information can be included in the technology hub.

- Water audits can assist in increasing water use efficiency. The National Cleaner Production Centre South Africa (NCPC-SA) continues with its drive to raise awareness in industry and government about the importance of water management. Through its Industrial Water Efficiency (IWE) Project, companies can apply for free water assessments and assistance with implementing water efficiency in their plants.

Wastewater generation and energy use

The survey of effluent streams generated in the FVPI sector found that average volumes of 298 m^3/d discharged from canning processes, 274 m^3/d from juicing processes, 595 m^3/d from freezing processes, and an average 407 m^3/d for the industry as a whole. Energy use figures in the industry were more difficult to obtain, but ranged from around

2780 to 14000 kWh/d. Load shedding of electricity had a significant impact on the Agri-processing sector, as it disrupts the processing of products and in many cases results in damaged/spoilt products that need to be dumped due to either poor quality or hygiene risks. In most facilities, the equipment needs to be cleaned after a load shedding stoppage, resulting in additional washing water being used and causing downtime during production. This downtime can necessitate that additional hours/overtime have to be worked to process products within specified time limits.

With regards to wastewater management, it can be concluded that advanced treatments are not generally practiced within the industry. Whilst most facilities perform at least a primary wastewater treatment, there seems to be less motivation for facilities to invest in secondary treatments, possibly due to the lengthy pay-back periods associated with the capital expenditure. Only three facilities of the 19 included in the final sample practiced advanced/tertiary treatment. The choice of disposal routes for the final effluent was also determined by the nature of the surroundings. Rural settings most commonly saw irrigation as the preferred disposal route, whilst in urban environments municipal wastewater systems were most often preferred.

Conclusions and recommendations

A number of factors affecting the FVPI in South Africa need to be addressed to ensure the global competitiveness of the local industry. Some of these include the impact of the COVID-19 pandemic, pricing pressures (local/global), water shortages during periods of drought, economic impacts (access to capital), export regulations, and changing consumer trends.

Regarding water and wastewater management in these industries in particular, the challenges for the producers include reduced water availability (especially during periods of water scarcity) and water quality. Because of the high water quality requirements for food industry process water, water recycling presents a number of challenges when considering this as option to reduce the freshwater intake of the industry.

Overall, areas that require attention include, improvement of licencing processes (reducing the ever-increasing delays in obtaining the necessary permissions), the improvement of cooperative governance, an increase in groundwater use in comparison to surface water, the improvement of sensing and flow measurement technologies, and the establishment of effective water governance partnerships.

Related project:
Natsurv 14: Water and wastewater management in the fruit and vegetable processing industry (Edition 2)
(**WRC project no. 2848**). For more information contact WRC Research Manager, Dr John Zvimba at Email: johnz@wrc.org.za